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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/317,536	05/24/99	ZHAO	E 97RSS256-DIV

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SNELL & WILMER LLP
ONE ARIZONA CENTER
400 EAST VAN BUREN
PHOENIX AZ 85004-0001

EXAMINER	
OWENS, D	
ART UNIT	PAPER NUMBER
2811	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/317,536

Applicant(s)

ZHAO ET AL.

Examiner

Douglas W Owens

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 16-33 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 16-33 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claims ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. & 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____.
- 18) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 16-20, 23 and 27-29 are rejected under 35 U.S.C. 102(b) as being anticipated by Havemann et al., US patent No. 5,747,880.

Regarding claim 16, Havemann et al. teaches an interconnect comprising:

one or more metal lines (24) having gaps between them;

low-k material (28) between the metal lines, wherein the low-k material has a height and one or more vertical portions;

a protective layer (56) over the metal lines and the low-k material, wherein the protective layer covers a vertical portion of the low-k material;

a dielectric layer (30) over the protective layer;

a via in the dielectric layer;

a metal (32) filling the via;

a second metal layer (34) over the dielectric layer; and

an opening in the protective layer to allow contact between the metal in the via and the metal lines.

Regarding claim 17, Havemann et al. teaches an interconnect structure, wherein the protective layer comprises an oxide.

Regarding claim 18, Havemann et al. teaches an interconnect structure, wherein the oxide comprises silicon dioxide (Col. 7, lines 3 and 4).

Regarding claims 19 and 29, Havemann et al. teaches an interconnect, wherein the protective layer comprises a dielectric material.

Regarding claims 20, 23 and 27, Havemann et al. teaches an interconnect, wherein the low-k material comprises a porous silicon dioxide, and the protective layer is silicon nitride.

Regarding claim 28, Havemann et al. teaches an interconnect structure comprising:

- a plurality of metal lines (24) on a substrate;
- a low-k dielectric (28) between the metal lines;
- a second dielectric (30) above the metal lines;
- a protective layer (56) between the second dielectric and the low-k dielectric; and
- a conductive feature (32) within the second dielectric and the protective layer,

wherein the conductive feature is in contact with at least one of the metal lines.

It is inherent that the protective layer and the second dielectric layer would have had etch selectivity since they comprise different materials. (Col. 7, lines 1-8, Col. 8, lines 5-9)

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

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invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Admitted Prior Art and Chiang applied to 16-21 and 23-31

4. Claims 16-21, and 23-31, are rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art in view of Chiang et al., US patent No., 5,886,410.

Regarding claims 16 and 28, admitted prior art teaches an interconnect comprising:

- a plurality of metal lines on a substrate formed from a first metal layer having gaps between said lines;

- low-k material filling the gaps between the metal lines and having a height and vertical portions;

- a dielectric layer formed over the low-k material and metal lines;

- vias etched in the dielectric layer;

- a second metal layer for filling the vias, said second metal layer providing a conductive feature in the second dielectric layer, wherein the conductive feature is in contact with at least one of the plurality of metal lines; and

- a third metal layer over the dielectric layer.

Admitted prior art does not teach a protective layer disposed on top of the low-k material layer, wherein said protective layer has openings for allowing the metal in the vias to contact the first metal lines. Chiang et al. Teaches an interconnect wherein a protection layer (110) is disposed on top of the low-k material layer, said protection layer having openings for allowing metal in the vias to contact the metal lines. It would have been obvious to one of ordinary skill in the art at the time the invention was made to

incorporate the teaching of Chiang with admitted prior art since the protection layer will improve the mechanical strength of the interconnect system. Furthermore, it is obvious to form openings in the protection layer in order to electrically connect the conductive lines.

Regarding claims 17, 18, 19, 20, 21, 23, and 29, admitted prior art does not teach an interconnect wherein the protective layer is an oxide, silicon dioxide, a dielectric, or silicon carbon. Chiang teaches an interconnect wherein the protective layer is silicon dioxide or a silicon dioxide combined with a silicon nitride. It would have been obvious to one of ordinary skill in the art to use an oxide, silicon dioxide, silicon nitride, or silicon carbon since they are well known materials, and are well suited for their intended use. Furthermore, these materials are well known for their use as dielectrics.

Regarding claims 24 and 25, admitted prior art teaches an interconnect wherein the first metal layer can be an aluminum alloy or tungsten, the metal filling the vias can be an aluminum alloy or tungsten, and the second metal layer can be an aluminum alloy or tungsten.

Regarding claims 26 and 27, admitted prior art teaches an interconnect wherein the dielectric layer comprises silicon dioxide. Admitted prior art does not teach an interconnect wherein the protective layer is silicon nitride, and the low-k material is an organic low-k material. Chiang teaches an interconnect wherein the protective layer is silicon nitride, and the low-k material is an organic low-k material. Neither admitted prior art, nor Chiang teach a low-k dielectric layer comprising a porous silicon dioxide. It

would have been obvious to one of ordinary skill in the art to incorporate the teaching of Chiang into the device taught by admitted prior art since the organic material taught by Chiang has a dielectric constant in the desired range. Furthermore, silicon nitride and porous silicon dioxide are well known materials that are well suited for their intended use and would have been obvious to use. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945)

Regarding claim 30, neither admitted prior art, nor Chiang et al. teach an interconnect structure including a liner. It is conventional in the art to employ liners in interconnect structures and would have been obvious to one of ordinary skill to do so, since it is desirable to prevent impurities from diffusing to unwanted areas of the device.

Regarding claim 31, neither admitted prior art, nor Chiang et al. teach an interconnect structure, wherein the liner material from the group comprising titanium, titanium nitride, tantalum, tantalum nitride, aluminum, copper, and tungsten nitride. Titanium, titanium nitride, tantalum, tantalum nitride, and tungsten nitride are known materials that exhibit barrier properties. It would have been obvious to one of ordinary skill in the art to use a known material for the barrier, since the materials listed are suited for the intended use.

Admitted Prior Art, Chiang, and Chen Applied to Claims 22, 32 and 33

5. Claims 22, 32 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over admitted prior art and Chiang et al. as applied to claims 16-21, and 28 above, and further in view of Chen et al. US patent No. 5,317,192.

Regarding claims 22 and 32 neither admitted prior art, nor Chiang et al. teach an interconnect wherein a spacer is disposed on the vertical portion of the low-k material in the vias between the low-k dielectric and the conductive feature. Chen teaches an interconnect wherein a spacer (28) is disposed on the vertical portion of the dielectric. It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teaching of Chen into Chiang's device, since the sidewall spacer would have prevented lateral diffusion of impurities.

Regarding claim 33, neither admitted prior art, nor Chiang et al. or Chen teach an interconnect including a liner over a spacer. The incorporation of the additional layer comprising the liner is conventional in the formation of interconnect structures. It would have been obvious to one of ordinary skill in the art to incorporate such a liner since it is desirable to prevent the vertical diffusion of impurities.

Havemann and Claims 21, 24, 25, 26, 30 and 31

6. Claims 21, 24, 25, 26, 30 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Havemann et al.

Regarding claim 21, Havemann et al. does not teach an interconnect, wherein the protective layer comprises silicon carbon. It would have been obvious to one of ordinary skill to use silicon carbon, since it is a known material that is suited for the intended use.

Regarding claim 24, Havemann et al. teaches an interconnect, wherein the first metal layer is an aluminum alloy. Havemann et al. does not teach an interconnect, wherein the metal filling is tungsten and the second metal layer is an aluminum alloy.

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Havemann et al. teaches a metal filling and a second metal layer. It is well known to use tungsten plugs in interconnect devices, and would have been obvious to one of ordinary skill to select tungsten as a matter of obvious design choice. It would have been obvious to use an aluminum alloy for the second metal layer since it is a known material that is suited for the intended use. Furthermore, Havemann et al. teaches a first metal layer that is aluminum alloy, so it would be obvious to use the same material in the second layer since it would reduce the cost of fabrication.

Regarding claim 25, Havemann et al. teaches an interconnect, wherein the first metal layer is an aluminum alloy. Havemann does not teach an interconnect, wherein the metal filling and the second metal layer is an aluminum alloy. It would have been obvious to one of ordinary skill in the art to use an aluminum alloy for the metal filling and the second metal layer since it is a known material that is suited for the intended use. Furthermore, since Havemann et al. teaches a first metal layer comprising an aluminum alloy, it would be obvious to use the same material for the metal filling and the second metal layer since it will reduce the cost of production.

Regarding claim 26, Havemann et al. teaches an interconnect, wherein the dielectric layer comprises silicon dioxide, and the protective layer comprises silicon nitride. Havemann does not teach a low-k material comprising an organic low-k material. Havemann teaches a low-k material comprising a porous oxide. It would have been obvious to one of ordinary skill in the art to use an organic low-k dielectric, since it is a known material that is well suited for the intended use. Furthermore, it is conventional in the art to use organic dielectrics where a low-k dielectric is needed.

Regarding claims 30 and 31, Havemann et al. does not teach an interconnect, including a liner, wherein said liner comprises material selected from the group consisting of titanium, titanium nitride, tantalum, tantalum nitride, aluminum, copper, and tungsten nitride. It is conventional in the art to include liners in interconnect devices. It would have been obvious to one of ordinary skill in the art to incorporate a liner since it is desirable to prevent unwanted diffusion of impurities. Additionally, many of the materials listed for use in the liner are known to have barrier properties. It would have been obvious to one of ordinary skill to select a known material that is suited for the intended use.

Havemann and Chen Applied to Claims 22, 32 and 33

7. Claims 22, 32, and 33 rejected under 35 U.S.C. 103(a) as being unpatentable over Havemann et al. as applied to claims 16-21 and 23-31 above, and further in view of Chen et al.

Regarding claims 22 and 32, Havemann et al. does not teach a spacer between the low-k dielectric and the conductive material. Chen teaches an interconnect wherein a spacer is disposed on the vertical portion of the dielectric. It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teaching of Chen into Havemann's device, since the sidewall spacer would have prevented lateral diffusion of impurities.

Regarding claim 33, neither Havemann et al., nor Chen teach an interconnect including a liner over a spacer. The incorporation of the additional layer comprising the liner is conventional in the formation of interconnect structures. It would have been

obvious to one of ordinary skill in the art to incorporate such a liner since it is desirable to prevent the vertical diffusion of impurities.

Response to Arguments

Response to Arguments Under 35 U.S.C. § 102

8. Applicant's arguments filed March 14, 2000 have been fully considered but they are not persuasive.

The applicant argues that Havemann does not teach a protective layer which covers at least one vertical portion of the low-k material. Layer "56", which has protective properties, covers the entire surface of the low-k material, which any portion of could be considered selected and considered to be vertical.

The applicant argues that layers "56" and "30" are not selected to provide etch selectivity. Since Havemann teaches that different materials can be used for layers "56" and "30" (Col. 7, lines 1-8, Col. 8, lines 5-9) respectively, it is inherent that they would have had different etch selectivity.

The applicant argues that Havemann does not teach a protective layer covering at least one vertical portion of a low-k material. Any portion of the low-k material could have been selected from the layer and considered vertical. Moreover, a vertical portion of low-k material (28) can be seen in Fig. 6F between two metal portions (24), wherein the vertical portion is clearly covered by the protective layer (56).

The applicant argues that Havemann does not teach layers "56" and "30" that preferably comprise distinct materials. This teaching can be found in Col. 7, lines 1-8 and Col. 8, lines 5-9.

Response to Arguments Under 35 U.S.C. § 103

Admitted Prior Art and Chiang

The applicant argues that Chiang et al. does not teach a protective layer which covers at least one vertical portion. The hardmask (110) taught by Chiang et al. would have had protective properties. The hardmask covers the entire surface of the low-k material (108), any portion of which could be selected that would be considered vertical.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

The applicant argues that it would not have been obvious to incorporate a liner into the device. As stated above, it is conventional in the art to form liners in interconnect structures for the prevention of vertical diffusion, among other reasons. Although the spacer taught by Chen also can prevent diffusion of impurities, the spacers would not have prevented vertical diffusion of impurities. Moreover, repetition of layers is not considered to have any patentable weight.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. US patent No. 5,929,524 to Drynam et al.

10. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Douglas W Owens whose telephone number is 703-308-6167. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 703-308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

DWO
December 18, 2000

Tom Thomas
703-308-2772
703-308-7722